# Researchers find new way to use electric fields to deliver cancer treatment

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A team of researchers has devised a new way to target tumors with cancer-fighting drugs, a discovery that may lead to clinical treatments for cancer patients.

Called iontophoresis, the technique delivers high concentrations of chemotherapy to select areas, reducing the risk of damaging healthy tissue, according to a study this week in *Science Translational Medicine*.

"A big challenge with many drugs is getting them where they need to go," said Lissett Bickford, an assistant professor in the Department of Biomedical Engineering and Mechanics and the Department of Mechanical Engineering, "This technology basically forces drugs directly to and through the tumor, allowing all cancer cells in the treatment zone to get that exposure."

Bickford, who now directs the Medical Devices and Drug Delivery Lab at the Institute for Critical Technology and Applied Science at Virginia Tech, participated in the study during her postdoctoral fellowship at the University of North Carolina at Chapel Hill, where she worked with lead author Joseph DeSimone, the Chancellor's Eminent Professor of Chemistry.

Chemotherapy kills cancer cells, but it's toxic to healthy cells, too.

When it's injected into the bloodstream, only a small amount of the drug actually gets to the tumor. The rest travels through the body, often causing side effects that may force patients to postpone or stop treatment.

And some tumors, such as those caused by pancreatic cancer, aren't well-connected to the circulatory system, blunting chemotherapy's effectiveness.

The new technique, developed by a team of researchers at the University of North Carolina and Duke University, uses an electric field to propel drugs into the tumor, like a surfer riding a wave.

The electric field is generated by a small device that can be implanted in a tumor or placed on the skin. The device, which the researchers designed and built themselves, contains a reservoir of chemotherapy.

When the device is turned on, the electric field pushes the drug into the entire tumor, despite pressure from the surrounding area—a factor that has complicated other local drug delivery strategies.

In mice with human inflammatory breast cancer, combining local iontophoretic chemotherapy with intravenous chemotherapy increased survival time, compared with either treatment alone. The effect was even more dramatic when combined with radiation. Chemotherapy administered though the device also shrank human pancreatic tumors in mice.

The researchers also found that for mice already receiving IV chemotherapy, adding local chemotherapy with the device increased the amount of the drug in the tumor, but barely elevated the concentration in the blood plasma – which could mean fewer side effects.

These results suggest that local, iontophoretically-delivered chemotherapy could be a valuable addition to an oncologist's toolbox, especially as an auxiliary to other treatments.

Local delivery may allow doctors to use more potent anti-cancer drugs that might not be well-tolerated systemically at high concentrations, researchers said.

Multi-drug cocktails are often more effective than single agents, but some are so toxic that they can normally only be given to patients who are otherwise considered healthy.

"Yet, most patients who have metastatic cancer are probably not that healthy, and that limits the patient pool" Bickford said. But with this local-delivery strategy, greater amounts of powerful drug mixtures could be unleashed only to the tumors, largely sparing the rest of the body from high dosages.

"This may ultimately lead to a reduction in the morbidity and mortality rates commonly found in different types of cancer," said first author James Byrne, a postdoctoral researcher and medical student at the University of North Carolina.

Patrick Dillon, an associate professor of hematology and oncology at the University of Virginia who was not involved in the research, said that the new technique has potential clinical applications, and believes that "the use of novel drug delivery devices such as this will improve the experience of cancer treatment for an important segment of the cancer patient population."

DeSimone has won numerous awards and distinctions for his research, which explores the interface between manufacturing and medicine. He received his doctoral degree in chemistry from Virginia Tech under the late James McGrath, a University Distinguished Professor and Ethyl Corporation Professor of Chemistry in the College of Science.

"It was a great experience as an engineer to do the actual device fabrication and testing, learn about pharmacokinetics, and do biodistribution studies all while working with clinicians and shadowing patients," Bickford said. "It was a truly multidisciplinary effort."

**More information:** Local iontophoretic administration of cytotoxic therapies to solid tumors, *Science Translational Medicine*, stm.sciencemag.org/lookup/doi/ … scitranslmed.3009951

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